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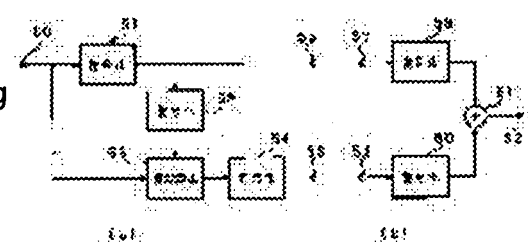
(54) HIGH EFFICIENCY CODING AND DECODING SYSTEM

(57)Abstract:

PURPOSE: To prevent generation of a pre-echo in the system where interchangeability is provided even to a reproduction device fixed by an existing low bit rate, the system with high sound quality using a higher bit rate is able to be introduced and bits are arranged completely optimizingly with respect to signals of every property.



CONSTITUTION: A high efficiency coder is provided with plural coding circuits 51, 54, a decoding circuit 52 decoding a signal subjected to coding processing, and a difference calculation circuit 53 calculating a difference between an input signal and a signal subjected to decoding processing. Then the input signal is coded and the coded signal is decoded and a difference between the decoded signal and the input signal is further coded and the result is transmitted to the high efficiency decoder together with the coded input signal. Furthermore, the high efficiency decoder is provided with plural decoding circuits 59, 60 and an adder circuit 61 synthesizing decoded signals and the coded signal from the high efficiency coder is decoded and the result is synthesized on time base and output signal is obtained.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to high efficiency coding and the decryption system which consist of the high-efficiency-coding equipment which reduces the bit rates used in stereos, such as a digital audio signal recorded message sender for telephone and a motion-picture film projection system, or the so-called multi-surround sound system, a transmission medium with which the signal encoded by this equipment is transmitted or recorded, and high efficiency decryption equipment which decrypts the signal transmitted and encoded.
[0002]
[Description of the Prior Art] Although it is in the technique and the equipments of high efficiency coding of a signal, such as an audio or voice, variously For example, block the audio signal of a time domain etc. for every unit time amount, change the signal of the time-axis for this the block of every into the signal on a frequency shaft (orthogonal transformation), and it divides into two or more frequency bands. Without blocking the so-called conversion coding method which is a blocking frequency band division method encoded for every band, the audio signal of a time domain, etc. for every unit time amount The band part tally number-ized (sub band coding: SBC) method which is a deblocking frequency band division method divided and encoded to two or more frequency bands can be held. Moreover, the technique and equipment of high efficiency coding which combined the above-mentioned formation of a band part tally number and above-mentioned conversion coding are also considered, and in this case, after the above-mentioned band part tally number-ized method performs band division, orthogonal transformation of the signal for this every band will be carried out to the signal of a frequency domain by the above-mentioned conversion coding method, and it will encode for each [by which orthogonal transformation was carried out] of this band of every.
[0003] As a filter for band division used in the formation of a band part tally number mentioned above here, there are filters, such as QMF (Quadrature Mirror filter), for example, and the filter of this QMF is reference "digital coding OBU speech Inn subbans" ("Digital coding of speech in subbands" R.E.Crochiere, BellSyst.Tech.J., Vol.55, No.8 1976). It is stated. The filter of this QMF is divided into two at bandwidths [band], and in case the band which carried out [above-mentioned] division in the filter concerned is compounded behind, it has been the description that the so-called aliasing does not occur.
[0004] moreover, reference -- "-- poliphase KUADORACHUA fill TAZU - new band part tally number-ized technical" ("Polyphase Quadrature filters-A new subband coding technique", Joseph H.Rothweiler ICASSP 83, BOSTON) -- a poliphase KUADORACHUA filter (Polyphase Quadrature filter) etc. -- etc. -- the filter division technique and equipment of a bandwidth are described. In this poliphase KUADORACHUA filter, in case it divides into two or more bands of bandwidths [signal], it has been the description that it can divide at once.
[0005] Moreover, as orthogonal transformation mentioned above, an input audio signal is blocked with the frame of predetermined unit time amount, and orthogonal transformation which changes a time-axis into a frequency shaft by carrying out discrete Fourier transform (DFT), a discrete cosine transform (DCT), or a MODIFAIDO discrete cosine transform (MDCT) to every block (frame) concerned occurs, for example. in addition, about Above MDCT Reference "time domain aliasing cancellation A basic filter bank design The used subband / conversion coding" ()
["Subband/Transform Coding Using Filter Bank Designs Based on Time Domain Aliasing Cancellation,] ["] J. It is stated to P.Princen A.B.Bradley and Univ.of Surrey Royal Melbourne Inst.of Tech.ICASSP 1987.
[0006] Furthermore, as frequency-division width of face in the case of quantizing each frequency component by which frequency band division was carried out, there is band division which took into consideration human being's acoustic-sense property, for example. That is, in the higher region currently generally called the critical band (critical band), bandwidth may divide an audio signal into the band of plurality (for example, 25 bunt) with bandwidth which becomes

large. Moreover, in case the data for every band at this time are encoded, predetermined bit allocation or coding according to accommodative bit allocation the whole band is performed for every band. For example, in case the MDCT multiplier data which MDCT processing was carried out [above-mentioned] and obtained are encoded by the above-mentioned bit allocation, coding will be performed with the accommodative allocation number of bits to the MDCT multiplier data for every band obtained by MDCT processing for every above-mentioned block.
[0007] Two technique and equipment of a degree are known as the above-mentioned bit allocation technique and equipment for it.
[0008] For example, by reference "adaptive transform coding of a sound signal" ("Adaptive Transform Coding of Speech Signals", IEEE Transactions of Accoustics, Speech, and Signal Processing, vol.ASSP-25, No.4, and August 1977), bit allocation is performed based on the magnitude of the signal for every band.
[0009] Moreover, the technique and equipment which obtain the required S/N for every band and perform fixed bit allocation by using auditory masking are described by reference "digital coding about the demand of the perception of a critical band encoder -acoustic-sense system" ("The critical band coder -- digital encoding of theperceptual requirements of the auditory system", and M.A.Kransner MIT and ICASSP 1980), for example.
[0010]
[Problem(s) to be Solved by the Invention] By the way, in the conventional high-efficiency-coding technique and equipment which were mentioned above, there is already a trouble that the system of the quality of loud sound using a higher bit rate cannot be introduced, by the reason the playback machine (decoder) fixed with a certain low bit rate is used, for example.
[0011] Moreover, there is also a trouble that the property of an output signal deteriorates greatly with the property of an input signal, by the reason for the ability not to perform completely optimal bit allocation to the input signal of all properties. That is, when conventional coding equipment is used, ** - this are the cases where coding processing of the input signal which has the change of amplitude information with the case rapid, for example where the quality of an output signal deteriorates greatly depending on the property of the input signal to coding equipment is carried out. In such a case, from conventional sign decryption equipment to an output signal, the noise called the so-called Puri Echo occurs.
[0012] Then, this invention is proposed in view of the above actual condition. Can introduce the system of the quality of loud sound using a higher bit rate which has compatibility also to the playback machine (decoder) fixed with the existing low bit rate, and the input signal of all properties is received. Without being able to perform completely optimal bit allocation and the property of an output signal deteriorating greatly with the property of an input signal It aims at offering high efficiency coding which can obtain the high-efficiency-coding output which Puri Echo does not generate in a decryption equipment side, and a decryption system.
[0013]
[Means for Solving the Problem] High efficiency coding and the decryption system of this invention Two or more coding networks which are proposed in order to attain the object mentioned above, and encode the supplied signal, The high-efficiency-coding equipment possessing the unit or two or more decryption circuits which decrypt the signal by which coding processing was carried out, and the calculus-of-finite-differences appearance circuit which computes difference with the signal by which decryption processing was carried out with the input signal, It comes to have high efficiency decryption equipment possessing two or more decryption circuits which decrypt the signal by which coding processing was carried out, and a synthetic means to compound the signal by which decryption processing was carried out. To the above-mentioned high-efficiency-coding equipment Decryption processing of the coded signal which carried out coding processing of the input signal concerned while carrying out coding processing of the input signal is carried out. Compute the difference of the signal and input signal by which decryption processing was carried out [above-mentioned], and the coding technique which transmits the coded signal which carried out coding processing of the differential signal concerned, and the coded signal which carried out coding processing of the input signal to the above-mentioned high efficiency decryption equipment is applied. It is characterized by applying the decryption technique which compounds on a time-axis and is made into an output signal to the above-mentioned high efficiency decryption equipment, after carrying out decryption processing of the coded signal by which transmission was carried out [above-mentioned].
[0014] Here, the circuit where using the same circuit or a different circuit and/or two or more decryption circuits in the above-mentioned high-efficiency-coding equipment, or two or more decryption circuits in the above-mentioned high efficiency decryption equipment are also the same, or a different circuit can be used for two or more coding networks in the above-mentioned high-efficiency-coding equipment. Moreover, the above-mentioned high efficiency decryption equipment can perform decryption processing only using some coded signals of the differential signal of the coded

signal of the above-mentioned input signal sent from the above-mentioned high-efficiency-coding equipment and plurality, or an unit, or the coded signal of the above-mentioned input signal. Furthermore, it performs that the above-mentioned high-efficiency-coding equipment's outputting the coded signal of a singular input signal and the coded signal of two or more above-mentioned differential signals and/or the above-mentioned high efficiency decryption equipment carry out decryption processing, and compound the coded signal of the coded signal of the input signal of the unit of high-efficiency-coding equipment, and two or more above-mentioned differential signals.
[0015] Moreover, in high efficiency coding and the decryption system of this invention, the coding network in the above-mentioned high-efficiency-coding equipment shall perform nonlinear quantization, and the decryption circuit in the above-mentioned high-efficiency-coding equipment and high efficiency decryption equipment shall use nonlinear reverse quantization only for performing nonlinear reverse quantization or coding of the differential signal in the above-mentioned high-efficiency-coding equipment only at a decryption of the coded signal of the differential signal in high efficiency decryption equipment using nonlinear quantization. Furthermore, reversible sign decryption processing is performed in the coding network of the differential signal in the above-mentioned high-efficiency-coding equipment, and the decryption circuit of the coded signal of the differential signal in high efficiency decryption equipment. Moreover, the coding network of the above-mentioned high-efficiency-coding equipment computes the degree of a masking effect, the die length of each processing block is determined, and the coding network of the above-mentioned differential signal performs bit assignment which depended more mostly to the acoustic-sense permissible noise spectrum. Furthermore, the coding network of the above-mentioned high-efficiency-coding equipment divides the signal on a frequency shaft to two or more bands while changing the signal on a time-axis into the signal on a frequency shaft by orthogonal transformation, and the decryption circuit of the above-mentioned high efficiency decryption equipment changes the signal of two or more bands on a frequency shaft into the signal on a time-axis by reverse orthogonal transformation. A reverse modification discrete cosine transform (IMDCT) is used as reverse orthogonal transformation, using a modification discrete cosine transform (MDCT) as the above-mentioned orthogonal transformation at this time. Furthermore, the coding network of the above-mentioned high-efficiency-coding equipment divides the signal of the single band on a time-axis into the signal of two or more bands with a mulberry DORACHA mirror filter (QMF), and the decryption circuit of the above-mentioned high efficiency decryption equipment compounds the signal divided into two or more bands on a time-axis with the in berth mulberry DORACHA mirror filter (IQMF) to the signal of a single band. Moreover, the above-mentioned high-efficiency-coding equipment and high efficiency decryption equipment can process the signal for two or more channels.
[0016] Next, high efficiency coding and the decryption system of this invention have the transmission medium which records or transmits the encoded signal, and the above-mentioned high-efficiency-coding equipment at this time separates two or more coded signals to output in one sink block, and is recorded or transmitted to the above-mentioned transmission medium.
[0017]
[Function] If according to this invention the difference of an input signal and the signal which carried out decryption processing after carrying out coding processing of this input signal is a noise component generated by coding and a decryption of an input signal, therefore the coded signal of this input signal and the coded signal of a differential signal are decrypted with high efficiency decryption equipment and it compounds on a time-axis, it will become possible to make property degradation of the output signal depending on the property of an input signal mitigate.
[0018] moreover, even when the decryption circuit fixed with the low bit rate which already exists in high efficiency decryption equipment, for example is used according to this invention By preparing two or more decryption circuits in high efficiency decryption equipment, performing decryption processing in each decryption circuit, and compounding each output signal (coded signal) of the high-efficiency-coding equipment of this invention on a time-axis It becomes possible to decrease the quality difference of the input signal of high-efficiency-coding equipment, and the output signal of high efficiency decryption equipment, using the existing decryption circuit.
[0019]
[Example] Hereafter, with reference to a drawing, the example of the high-efficiency-coding equipment (encoder) which constitutes high efficiency coding and the decryption system of this invention, and high efficiency decryption equipment (decoder) is explained.
[0020] The configuration of one example of high efficiency coding of this invention and a decryption system is shown in drawing 1 . (a) of this drawing 1 shows the configuration of the high-efficiency-coding equipment of this invention, and (b) of drawing 1 shows the configuration of the high efficiency decryption equipment of this invention.
[0021] Namely, high efficiency coding and the decryption system of this invention example Two or more coding networks 51 and 54 which encode the supplied signal as shown in (a) of drawing 1 , the difference which computes the

difference of the unit or two or more decryption circuits 52 which decrypt the signal by which coding processing was carried out, and the signal by which decryption processing was carried out with the input signal, as it is indicated in (b) of drawing 1 as the high-efficiency-coding equipment possessing the calculation circuit 53 It comes to have high efficiency decryption equipment possessing two or more decryption circuits 59 and 60 which decrypt the signal by which coding processing was carried out, and the adder circuit 61 as a synthetic means to compound the signal by which decryption processing was carried out. Decryption processing of the coded signal which carried out coding processing of the input signal concerned here at the above-mentioned high-efficiency-coding equipment while carrying out coding processing of the input signal is carried out. Compute the difference of the signal and input signal by which decryption processing was carried out [above-mentioned], and the coding technique which transmits the coded signal which carried out coding processing of the differential signal concerned, and the coded signal which carried out coding processing of the input signal to the above-mentioned high efficiency decryption equipment is applied. After carrying out decryption processing of the coded signal by which transmission was carried out [above-mentioned], he is trying to apply the decryption technique which compounds on a time-axis and is made into an output signal to the above-mentioned high efficiency decryption equipment.

[0022] First, in (a) of drawing 1 , the 0-22kHz audio PCM signal for two or more channels is supplied to the high-efficiency-coding equipment input terminal 50 of this invention example. This input signal is sent to a coding network 51 and the calculus-of-finite-differences appearance circuit 53.

[0023] A coding network 51 has a configuration equivalent to conventional coding equipment, and performs high efficiency coding for input digital signals, such as an audio signal, using each technique of the formation (SBC) of a band part tally number, adaptive transform coding (ATC), and adaptation bit allocation (APC-AB). The output signal of a coding network 51 is sent to the high-efficiency-coding equipment output terminal 55 and the decryption circuit 52.

[0024] The decryption circuit 52 has a configuration equivalent to conventional decryption equipment, decrypts the signal encoded by the above-mentioned coding network 51, and returns it to an audio PCM signal etc. In addition, this audio PCM signal includes the noise generated by the coding network 51 and the decryption circuit 52. The signal decrypted here is sent to the calculus-of-finite-differences appearance circuit 53.

[0025] The calculus-of-finite-differences appearance circuit 53 computes reception and its differential signal for two kinds of audio PCM signals different, respectively from an input terminal 50 and the decryption circuit 52. The differential signal computed here means the noise component generated by the coding network 51 and the decryption circuit 52. This differential signal is sent to a coding network 54.

[0026] Like a coding network 51, a coding network 54 has a configuration equivalent to conventional coding equipment, and performs high efficiency coding to the differential signal computed by the calculus-of-finite-differences appearance circuit 53. The output signal of a coding network 54 is sent to the high-efficiency-coding equipment output terminal 56.

[0027] In addition, by making this coding network 54 and the coding network 51 of the preceding paragraph into the same circuit, system magnitude of high-efficiency-coding equipment can be made small, and it becomes possible to stop the consumed electric power of cost or hardware low. Moreover, when the high-efficiency-coding circuit is already existing, it becomes possible to divert the coding network as it is.

[0028] Next, in (b) of drawing 1 , the high-efficiency-coding signal is supplied to the high efficiency decryption equipment input terminal 57 of this invention from the high-efficiency-coding equipment output terminal 55. This input signal is sent to the decryption circuit 59.

[0029] The decryption circuit 59 has a configuration equivalent to conventional decryption equipment, decrypts the coded signal sent from the high-efficiency-coding equipment output terminal 55, and returns it to an audio PCM signal etc. In addition, this decryption circuit 59 has a configuration equivalent to the decryption circuit 52 in (a) of drawing 1 . That is, the output signal of the decryption circuit 52 and the output signal of the decryption circuit 59 are equivalent. The signal decrypted here is sent to an adder circuit 61.

[0030] Moreover, the high-efficiency-coding signal is supplied to the high efficiency decryption equipment input terminal 58 of this invention from the high-efficiency-coding equipment output terminal 56. This input signal is sent to the decryption circuit 60.

[0031] Like the decryption circuit 59, the decryption circuit 60 has a configuration equivalent to conventional decryption equipment, decrypts the coded signal sent from the high-efficiency-coding equipment output terminal 56, and returns it to an audio PCM signal etc. The signal decrypted here is sent to an adder circuit 61.

[0032] For example, when the coding networks 51 and 54 in drawing 1 are circuits of the completely same configuration, also as for the decryption circuits 52, 59, and 60 in drawing 1 , it is most effective to use the circuit of

the same configuration. This can make small system magnitude of the high efficiency decryption equipment of this invention, and becomes possible [stopping the consumed electric power of cost or hardware low].

[0033] Furthermore, when the high-efficiency-coding circuit which is existing to the coding networks 51 and 54 in drawing 1 is used as mentioned above, it becomes possible to divert the high efficiency decryption circuit which is existing also to the decryption circuits 52, 59, and 60 in drawing 1 . Thereby, in order to consume the coding network of the same specification, and a decryption circuit to a large quantity, the unit price of a circuit falls and it becomes possible to lower the production cost of the high efficiency decryption equipment with which with equipment, and this invention is existing. [equipment / high efficiency coding / and] [decryption]

[0034] Moreover, in the high-efficiency-coding equipment of this invention, and decryption equipment, using existing coding and a decryption circuit means having the compatibility over existing high-efficiency-coding equipment and decryption equipment. For example, a sign and decrypting can be realized, securing tone quality equivalent to the present high efficiency sign decryption equipment by not receiving the coded signal outputted from the high-efficiency-coding equipment output terminal 56 in drawing 1 , but receiving only the coded signal outputted from the high-efficiency-coding equipment output terminal 55, in case the signal encoded with the high-efficiency-coding equipment of this invention is decrypted with existing high efficiency decryption equipment. Moreover, a sign and decrypting become realizable, securing tone quality equivalent to the present high efficiency sign decryption equipment by inputting a coded signal into one of the high efficiency decryption equipment input terminals 57 and 58 in drawing 1 , in case the signal encoded with existing high-efficiency-coding equipment is decrypted with the high efficiency decryption equipment of this invention. Moreover, for example, the same coded signal as the high efficiency decryption equipment input terminals 57 and 58 in drawing 1 can be inputted, and it can realize also by adding the function which chooses whether it adds to an adder circuit 61.

[0035] An adder circuit 61 adds two kinds sent from the decryption circuits 59 and 60 of decrypted signals. By performing addition in this adder circuit 61, generating of the quantizing noise generated in processing of a coding network 51 and the decryption circuit 59 is controlled. namely, the signal and quality by which the signal outputted from the output terminal 62 of high efficiency decryption equipment is supplied to the input terminal 50 of high-efficiency-coding equipment -- abbreviation -- it will be obtained as the same thing. Especially, in processing of a coding network 51 and the decryption circuit 59, it is effective to a specific input signal which emits a loud quantizing noise. The signal after addition processing is sent to the high efficiency decryption equipment output terminal 62.

[0036] From the high efficiency decryption equipment output terminal 62, the audio PCM signal decrypted by the high efficiency decryption equipment of this invention is outputted.

[0037] In this example, high efficiency coding is performed for input digital signals, such as an audio PCM signal, using each technique of the formation (SBC) of a band part tally number, adaptive transform coding (ATC), and adaptation bit allocation (APC-AB) in the coding network 51 and coding network 54 in drawing 1 . This technique is explained referring to drawing 2 .

[0038] With the concrete high-efficiency-coding equipment of this example shown in drawing 2 , while a filter etc. divides an input digital signal into two or more frequency bands, orthogonal transformation was performed for every frequency band, and to every [in consideration of the acoustic-sense property of human being who mentions the spectrum data of the acquired frequency shaft later] so-called critical band width of face (critical band), bit allocation was carried out accommodative and it has encoded. At this time, the band which divided critical band width of face further is used in a high region. Of course, the frequency-division width of face of not blocking according to a filter etc. is good also as division-into-equal-parts ****.

[0039] Furthermore, in this invention example, while changing a block size (block length) accommodative according to an input signal before orthogonal transformation, the small block which subdivided further critical band width of face (critical band) is performing floating processing in the critical band unit or the high region. In addition, this critical band is the frequency band divided in consideration of human being's acoustic-sense property, and is a band which that noise in case the mask of the pure sound concerned is carried out by the narrow-band band noise of the same strength near the frequency of a certain pure sound has. The perimeter wave number band whose bandwidth this critical band is large like the high region, for example, is 0-20kHz is divided into the critical band of 25.

[0040] That is, in drawing 2 , the 0-22kHz audio PCM signal is supplied to the input terminal 10. This input signal is divided into a 0-11kHz band and 11k-22kHz band by the band division filters 11, such as the so-called QMF mentioned above, and, similarly the signal of a 0-11kHz band is divided into a 0-5.5kHz band and a 5.5k-11kHz band by the band division filters 12, such as the so-called QMF.

[0041] The signal of 11k-22kHz band from the above-mentioned band division filter 11 is sent to the MDCT (Modified Discrete Cosine Transform) circuit 13 which is an example of a rectangular conversion circuit, the signal of the 5.5k-

11kHz band from the above-mentioned band division filter 12 is sent to the MDCT circuit 14, and MDCT processing of the signal of the 0-5.5kHz band from the above-mentioned band division filter 12 is carried out by being sent to the MDCT circuit 15, respectively. In addition, in each MDCT circuits 13, 14, and 15, MDCT processing is made based on the block size determined by the block decision circuits 19, 20, and 21 prepared for every band.
[0042] Here, the example of the block size in each MDCT circuits 13, 14, and 15 determined by the above-mentioned block decision circuits 19, 20, and 21 is shown in A and B of drawing 3 . In addition, the case (orthogonal transformation block size in short mode) where an orthogonal transformation block size is short is shown for the case (orthogonal transformation block size in long mode) where an orthogonal transformation block size is long in A of drawing 3 at B of drawing 3 .
[0043] In the example of this drawing 3 , three filter outputs have two orthogonal transformation block sizes, respectively. That is, to the signal of the 0-5.5kHz band by the side of low-pass, and the signal of the 5.5k-11kHz band of a mid-range, in the case of the long block length (A of drawing 2), the measurement size in 1 block is made into 128 samples, and when a short block is chosen (B of drawing 3), the measurement size in 1 block is considered as the block for every 32 samples. On the other hand, to the signal of 11k-22kHz band by the side of a high region, in the case of the long block length (A of drawing 3), the measurement size in 1 block is made into 256 samples, and when a short block is chosen (B of drawing 3), the measurement size in 1 block is considered as the block for every 32 samples. thus -- being the same in the measurement size of an orthogonal transformation block of each band, when a short block is chosen -- carrying out -- like a high region -- time resolution -- raising -- in addition -- and the class of window used for blocking is reduced.
[0044] In addition, the information which shows the block size determined in the above-mentioned block decision circuits 19, 20, and 21 is outputted from output terminals 23, 25, and 27 while it is sent to the below-mentioned adaptation bit allocation code-ized circuits 16, 17, and 18.
[0045] Again, the spectrum data or MDCT multiplier data of a frequency domain which MDCT processing was carried out in drawing 2 in each MDCT circuits 13, 14, and 15, and was obtained is gathered for every band which divided the critical band further, and is sent to the adaptation bit allocation code-ized circuits 16, 17, and 18 in the so-called critical band (critical band) or the high region.
[0046] In the adaptation bit allocation code-ized circuits 16, 17, and 18, it is made to carry out re-quantization (for it to normalize and quantize) of each spectrum data (or MDCT multiplier data) according to the number of bits which divided the critical band further and which was assigned for every band in the information and critical band (critical band), or high region of the above-mentioned block size.
[0047] The data encoded by each [these] adaptation bit allocation code-ized circuits 16, 17, and 18 are taken out through output terminals 22, 24, and 26. Moreover, in the adaptation bit allocation code-ized circuits 16, 17, and 18 concerned, the scale factor which shows whether the normalization about the magnitude of what kind of signal was made, and the bit length information which shows by what kind of bit length quantization was carried out are also searched for, and these are also simultaneously outputted from output terminals 22, 24, and 26.
[0048] Moreover, from the output of each MDCT circuits 13, 14, and 15 in drawing 2 , the energy for every band which divided the critical band further is searched for in the above-mentioned critical band (critical band) or a high region by calculating the square root of the root mean square of each amplitude value within the band concerned, for example etc. Of course, you may make it use for future bit allocation of the above-mentioned scale factor itself. In this case, since the operation of new energy count becomes unnecessary, it becomes economization of hard magnitude. Moreover, it is also possible to use the peak value of amplitude value, the average, etc. instead of the energy for every band.
[0049] Next, in the adaptation bit quota circuits 16, 17, and 18, the concrete technique of the above-mentioned bit allocation is explained.
[0050] If drawing 4 explains actuation of the adaptation bit allocation circuit in this case, the magnitude of a MDCT multiplier will be called for for every block, and that MDCT multiplier will be supplied to an input terminal 801. The MDCT multiplier supplied to the input terminal 801 concerned is given to the energy calculation circuit 803 for every band. In the energy calculation circuit 803 for every band, the signal energy about each band which re-divided the critical band further in the critical band or the high region is computed. The energy about each band computed in the energy calculation circuit 803 for every band is supplied to the energy dependence bit allocation circuit 804.
[0051] In the energy dependence bit allocation circuit 804, it comes to perform bit allocation which makes white quantizing noise using a certain rate of the 128Kbps in the usable total bit by the usable total bit generating circuit 802, and this example. The rate that this amount of bits occupies to the above-mentioned 128Kbps increases, so that unevenness of the spectrum of an input signal is so large that the toe nullity of an input signal is high at this time. In

addition, in order to detect unevenness of the spectrum of an input signal, the sum of the absolute value of the difference of the block floating multiplier of an adjoining block is used as an index so that it may mention later. And after that, bit allocation proportional to the pair numeric value of the energy of each band is performed about the calculated usable amount of bits so that it may mention later.

[0052] The bit allocation calculation circuit 805 depending on acoustic-sense allowance noise level calculates the amount of allowance noises for every critical band in consideration of the so-called masking effect etc. based on the spectrum data first divided for every above-mentioned critical band, and a part for the bit which lengthened the energy dependence bit from the above-mentioned usable total bit so that an acoustic-sense permissible noise spectrum might next be given is distributed. Thus, the called-for energy dependence bit and the bit depending on acoustic-sense allowance noise level are added, and each spectrum data (or MDCT multiplier data) is re-quantized by the adaptation bit allocation code-ized circuits 16, 17, and 18 of drawing 2 according to the number of bits assigned to the band which divided the critical band into two or more bands further in every critical band and the high region. Thus, the encoded data are taken out through the output terminals 22, 24, and 26 of drawing 2 .

[0053] If the acoustic-sense permissible noise spectrum calculation circuit in the bit allocation circuit 805 of the above-mentioned acoustic-sense permissible noise spectrum dependence is explained in more detail, the MDCT multiplier obtained in the MDCT circuits 13, 14, and 15 will be given to the permissible noise spectrum calculation circuit in the bit allocation circuit 805 concerned.

[0054] Drawing 5 is the block circuit diagram showing the outline configuration of one example in which the above-mentioned permissible noise spectrum calculation circuit was explained collectively. In this drawing 5 , the spectrum data of the frequency domain from the MDCT circuits 13, 14, and 15 are supplied to the input terminal 521.

[0055] The input data of this frequency domain is sent to the energy calculation circuit 522 for every band, and when the energy of every above-mentioned critical band (critical band) calculates total of each amplitude value square within the band concerned, for example, it is called for. The peak value of amplitude value, the average, etc. may be used instead of the energy for every band of this. Generally as an output from this energy calculation circuit 522, the spectrum of the total value of for example, each band is called the bark spectrum. Drawing 6 shows the bark spectrum SB for such every critical band. However, in this drawing 6 , in order to simplify a graphic display, 12 bands (B1 -B12) are expressing the number of bands of the above-mentioned critical band.

[0056] Reefing (convolution) processing which hangs and adds a predetermined weighting function to this bark spectrum SB here in order to take into consideration the effect in the so-called masking of the above-mentioned bark spectrum SB is performed. For this reason, each value of the output SB of the energy calculation circuit 522 for every above-mentioned band, i.e., this bark spectrum, is sent to the reefing filter circuit 523. This reefing filter circuit 523 consists of two or more delay elements which carry out sequential delay of the input data, two or more multipliers (for example, 25 multipliers corresponding to each band) which carry out the multiplication of the filter coefficient (weighting function) to an output from these delay elements, and a total adder which takes total of each multiplier output.

[0057] In addition, the above-mentioned masking says the phenomenon which the mask of other signals is carried out by a certain signal, and stops being able to hear with the property on human being's acoustic sense, and there are a time-axis masking effect by the audio signal of a time domain and this time-of-day masking effect by the signal of a frequency domain as this masking effect. According to these masking effects, even if a noise is in the part masked, this noise can be heard. For this reason, let the noise within the limits of [which is masked] this be a permissible noise in a actual audio signal.

[0058] Moreover, if one example of the multiplication multiplier (filter coefficient) of each multiplier of the above-mentioned reefing filter circuit 523 is shown, when setting the multiplier of the multiplier M corresponding to the band of arbitration to 1, A multiplier 0.15 with a multiplier M-2 with a multiplier M-1 a multiplier 0.0019 In a multiplier 0.0000086, reefing processing of the above-mentioned bark spectrum SB is performed by the multiplier M-3 with a multiplier M+1 by carrying out [a multiplier 0.4] the multiplication of the multiplier 0.007 for a multiplier 0.06 to the output of each delay element with a multiplier M+3 with a multiplier M+2. However, M is the integer of the arbitration of 1-25.

[0059] Next, the output of the above-mentioned reefing filter circuit 523 is sent to the subtraction machine 524. This subtraction machine 524 asks for the level alpha corresponding to the noise level in which the allowance in the collapsed field mentioned later is possible the account of a top. In addition, the level alpha corresponding to the noise level (allowance noise level) in which the allowance concerned is possible is the level which turns into an allowance noise level for every band of a critical band by performing reverse convolution processing, as mentioned later.

[0060] Here, the admissible function (function expressing masking level) of the ** sake which asks for the above-

mentioned level alpha is supplied to the above-mentioned subtraction machine 524. The above-mentioned level alpha is controlled by making this admissible function fluctuate. The admissible function concerned is supplied from the function generating circuit (n-ai) 525 which is explained below.

[0061] That is, if the number given sequentially from low-pass [of the band of a critical band] is set to i, it can ask for the level alpha corresponding to an allowance noise level by the following formula.

[0062] Alpha=S - (n-ai)

In this formula, n and a are the reinforcement of the bark spectrum with which reefing processing of a> 0 and the S was carried out by the constant, and the inside (n-ai) of a formula serves as an admissible function. n= 38 and a=-0.5 can be used as an example.

[0063] Thus, the above-mentioned level alpha is called for and this data is transmitted to a divider 526. It is for carrying out the reverse convolution of the above-mentioned level alpha in the field by which the reefing was carried out [above-mentioned] in the divider 526 concerned. Therefore, Massu Kings RESSHORUDO comes to be obtained from the above-mentioned level alpha by performing this reverse convolution processing. That is, this Massu Kings RESSHORUDO serves as an allowance noise spectrum. In addition, although the above-mentioned reverse convolution processing needs a complicated operation, it is performing the reverse convolution using the simplified divider 526 in this example.

[0064] Next, above-mentioned Massu Kings RESSHORUDO is transmitted to a subtractor 528 through the synthetic circuit 527. Here, the bark spectrum SB outputted namely, mentioned above from the energy detector 522 for every above-mentioned band is supplied to the subtractor 528 concerned through the delay circuit 529. Therefore, as shown in drawing 7 by the subtraction operation of above-mentioned Massu Kings RESSHORUDO and the bark spectrum SB being performed with this subtractor 528, below the level that shows the above-mentioned bark spectrum SB on the level of Massu Kings RESSHORUDO MS concerned will be masked. In addition, the above-mentioned delay circuit 529 is formed in order to delay the bark spectrum SB from the energy detector 522 in consideration of the amount of delay in each circuit before the above-mentioned synthetic circuit 527.

[0065] The output from the subtractor 528 concerned is sent to ROM with which it was taken out through the output terminal 531, for example, allocation number-of-bits information was beforehand remembered to be through the permissible noise amendment circuit 530 (not shown). This ROM etc. outputs the allocation number-of-bits information for every band according to the output (level of the difference of the energy of each above-mentioned band, and the output of the above-mentioned noise level setting-out means) obtained from the above-mentioned subtractor circuit 528 through the permissible noise amendment circuit 530.

[0066] Thus, an energy dependence bit and the bit depending on acoustic-sense allowance noise level are that are added and the allocation number-of-bits information is sent to the above-mentioned adaptation bit allocation code-ized circuits 16, 17, and 18, and each spectrum data of the frequency domain from the MDCT circuits 13, 14, and 15 is quantized here with the number of bits assigned for every band.

[0067] That is, if it summarizes, in the above-mentioned adaptation bit allocation code-ized circuits 16, 17, and 18, the spectrum data for every above-mentioned band will be quantized with the number of bits distributed according to the level of the difference of the energy of a band or peak value which divided the critical band concerned into two or more bands further in every band band (every critical band) and high region of the above-mentioned critical band, and the output of the above-mentioned noise level setting-out means.

[0068] By the way, in the case of composition, the data in which the so-called minimum audible curve RC which is human being's acoustic-sense property as shown in drawing 8 in the synthetic circuit 527 mentioned above supplied from the minimum audible curve generating circuit 532 is shown, and above-mentioned Massu Kings RESSHORUDO MS are compoundable. In this minimum audible curve, if noise absolute level becomes below this minimum audible curve, this noise can be heard. although it becomes what is different by the difference in the playback volume at the time of playback even if this minimum audible curve has the same coding for example, -- a realistic digital system -- the sound for example, to a 16-bit dynamic range -- since there is no difference in the easy method of entering so much, supposing the quantizing noise of the frequency band near 4kHz a lug is the easiest to hear cannot be heard, for example, in other frequency bands, it will be thought that the quantizing noise below the level of this minimum audible curve cannot be heard. Therefore, it assumes that usage depending on which the noise near 4kHz of the dynamic range which a system has in this way cannot be heard is carried out, and if an allowance noise level is obtained by compounding both this minimum audible curve RC and Massu Kings RESSHORUDO MS, the allowance noise level in this case can be carried out to to the part shown with the slash in drawing 8 . In addition, in this example, the level of 4kHz of the above-mentioned minimum audible curve is doubled with the minimum level of 20 bits. Moreover, this drawing 8 shows the signal spectrum SS simultaneously.

[0069] Moreover, in the above-mentioned permissible noise amendment circuit 530, the allowance [in / based on the information on an equal loudness curve for example / the output from the above-mentioned subtractor 528] noise level sent from the amendment information output circuit 533 is amended. It connected with the curve in quest of the sound pressure of the sound in each frequency which it is here, and an equal loudness curve is a characteristic curve about human being's acoustic-sense property, for example, the same magnitude as the pure sound of 1kHz hears, and is also called the equal loudness contour of loudness rating. moreover, the minimum audible curve RC which showed these loudness level contours to drawing 8 and abbreviation -- the same curve is drawn. In these loudness level contours, for example near 4kHz, the magnitude as 1kHz also with the same bottom of 8-10dB hears sound pressure from the place of 1kHz, and near 50Hz, unless it is higher than the sound pressure in 1kHz about 15dB conversely, the same magnitude does not hear at it. For this reason, the noise (allowance noise level) beyond the level of the above-mentioned minimum audible curve is understood are good to have the frequency characteristics given in the curve according to these loudness level contours. Since it is such, it turns out that amending the above-mentioned allowance noise level in consideration of the above-mentioned loudness level contours conforms to human being's acoustic-sense property.

[0070] The spectrum configuration depending on the acoustic-sense allowance noise level described above is built with the bit allocation using a certain rate of the usable total bit 128Kbps. This rate decreases, so that the toe nullity of an input signal becomes high.

[0071] Next, the amount division technique of bits between the two bit allocation technique is explained.

[0072] It returns to drawing 4 , and the signal from the input terminal 801 with which a MDCT circuit output is supplied is also given to the smoothness calculation circuit 808 of a spectrum, and the smoothness of a spectrum is computed here. In this example, the value which broke the sum of the absolute value of the difference between the neighbors of the absolute value of a signal spectrum by the sum of the absolute value of a signal spectrum is computed as smoothness of the above-mentioned spectrum.

[0073] The output of the smoothness calculation circuit 808 of the above-mentioned spectrum is given to the rate decision circuit 809 of bit division, and the rate of bit division between bit allocation of energy dependence and the bit allocation by the acoustic-sense permissible noise spectrum is determined here. It thinks that the rate of bit division does not have the smoothness of a spectrum, so that the output value of the smoothness calculation circuit 808 of a spectrum is large, and bit allocation with emphasis on the bit allocation by the acoustic-sense permissible noise spectrum is performed rather than bit allocation of energy dependence. The rate decision circuit 809 of bit division sends a control output to the multipliers 811 and 812 which control the magnitude of bit allocation of energy dependence, and the bit allocation by the acoustic-sense permissible noise spectrum, respectively. Here, a spectrum is temporarily smooth, and when the output of the rate decision circuit 809 of bit division to a multiplier 811 takes the value of 0.8 so that weight may be set to bit allocation of energy dependence, the output of the rate decision circuit 809 of bit division to a multiplier 812 is set to 1-0.8=0.2. The output of these two multipliers is added by the adder 806, serves as final bit allocation information, and is outputted from an output terminal 807.

[0074] The situation of the bit allocation at this time is shown in drawing 9 and drawing 10 . Moreover, the situation of the quantizing noise corresponding to this is shown in drawing 11 and drawing 12 . Drawing 9 shows the case where the spectrum of a signal is comparatively flat, and drawing 10 shows the case where a signal spectrum shows a high toe nullity. Moreover, the amount of bits for signal level dependence is shown by the inside QS of drawing of drawing 9 and drawing 10 , and the inside QN of drawing shows the amount of bits for bit allocation of acoustic-sense allowance noise level dependence. Signal level is shown by the inside L of drawing of drawing 11 and drawing 12 , and the inside NS of drawing shows a part for noise lowering according [the inside NN of drawing] a part for the noise lowering by part for signal level dependence to a part for bit allocation of acoustic-sense allowance noise level dependence.

[0075] First, the bit allocation for which the spectrum of a signal depended on acoustic-sense allowance noise level in drawing 11 which shows the case of being comparatively flat is useful in order to cross to all bands and to take large signal to noise ratio. However, comparatively little bit allocation is used in low-pass and a high region. This is because the sensibility to the noise of this band is small in acoustic sense. Although there are few parts of bit allocation depending on a signal energy level as an amount, it is preponderantly distributed to the frequency domain where inside low-pass signal level is high in this case so that a White noise spectrum may be produced.

[0076] On the other hand, as shown in drawing 12 , when a signal spectrum shows a high toe nullity, the amount of bit allocation depending on a signal energy level increases, and lowering of a quantizing noise is used in order to reduce the noise of a narrow band extremely. Concentration of the bit allocation depending on acoustic-sense allowance noise level is not tighter than this.

[0077] As shown in drawing 12 , improvement in the property in an isolated spectrum input signal is attained by the

sum of these both bit allocation.
[0078] Drawing 13 shows the decryption equipment of the fundamental this invention example for decrypting the encoded signal again in the decryption circuits 52, 59, and 60 in drawing 1 .
[0079] In this drawing 13 , the MDCT multiplier by which each band was quantized is given to the decryption equipment input terminals 122, 124, and 126, and the used block-size information is given to input terminals 123, 125, and 127. In the decryption circuits 116, 117, and 118, bit allocation is canceled using adaptation bit allocation information.
[0080] Next, the signal of a frequency domain is changed into the signal of a time domain in the IMDCT circuits 113, 114, and 115. The time domain signal of these partial bands is decrypted by the whole region signal, and is sent to an output terminal 110 by the IQMF circuits 112 and 111.
[0081] Next, the signal encoded by the high-efficiency-coding equipment of this invention example which mentioned above, the transmission medium, i.e., the media, of this invention example, is recorded or transmitted. That is, record is also included as transmission said here. What the above-mentioned coded signal was recorded on the record medium of the shape of a disk, such as an optical disk, a magneto-optic disk, and a magnetic disk, as media for record, the thing by which the above-mentioned coded signal was recorded on tape-like record media, such as a magnetic tape, or the semiconductor memory the coded signal was remembered to be, an IC card, etc. can be mentioned. Moreover, as media for transmission which does not include record, an electric wire or an optical cable, an electric wave, etc. can be mentioned.
[0082] In addition, about arrangement of the data in the media of this invention example, it becomes an array as shown, for example in (A) in drawing 14 , and (B). namely, one sink block -- sink information IS Sub information ISB outputted from the sub information ISA (the scale factor, WORD length) and the Maine information IMA which were outputted from the high-efficiency-coding equipment output terminal 55 in drawing 1 , and the high-efficiency-coding equipment output terminal 56 Maine information IMB from -- it shall become
[0083] In this case, it is effective to dissociate, to record or transmit the signal sent from each high-efficiency-coding equipment output terminals 55 and 56 into one sink block, and to decode and reproduce after that at the point that the bit string part which should be removed can be removed collectively, when lowering a bit rate and reproducing using existing high efficiency decryption equipment.
[0084] moreover -- for example, in case the data of a certain capacity recorded on media are copied on another media, in order to save the capacity of media and to realize more nearly prolonged record, it is effective at the point that the bit string part which should be removed can be removed collectively to record what removed the coded signal outputted from the high-efficiency-coding equipment output unit 56.
[0085] For example, especially the above bit arrays used the magneto-optic disk and the optical disk, they are applicable to the so-called mini disc (Mini Disc), magnetic tape media, a communication medium, etc.
[0086] In addition, it is also possible to make it a configuration which this invention is not limited only to this example and is different in two coding networks 51 and 54 in drawing 1 . Thereby, although the decryption circuit 52 and the decryption circuit 59 in drawing 1 are the same configuration, the decryption circuit 60 serves as a different configuration. That is, a coding network 51 has the relation to which the decryption circuits 52 and 59 and a coding network 54 corresponded with the decryption circuit 60, respectively. For example, it is possible to use for another coding network the band part tally number-ized method which is a deblocking frequency band division method at one of coding networks using the conversion coding method which is a blocking frequency band division method. In addition, since many so-called white-noise components are included (for example, since it is easy to carry out bit allocation of the direction which used for the coding network 54 the band part tally number-ized method currently divided into the same bandwidth uniformly to a perimeter wave number band), the input signal of a coding network 54 acts on validity more.
[0087] Moreover, in the high-efficiency-coding equipment of (a) of drawing 1 , it is also possible to have the structure which repeats a series of processings performed by coding networks 51 and 54, the decryption circuit 52, and the calculus-of-finite-differences appearance circuit 53 two or more times. That is, it is also possible to take two or more steps of layered structures of decrypting again the signal encoded by the coding network 54, computing difference with the input signal from the high-efficiency-coding equipment input terminal 50, and encoding it further. In addition, in connection with it, high efficiency decryption equipment serves as a configuration which increases a decryption circuit.

[0088] Moreover, since the input signal over the coding network 54 in drawing 1 is a differential signal of the signal supplied from the high-efficiency-coding equipment input terminal 50, and the signal by which sign decryption processing was carried out in the coding network 51 and the decryption circuit 52, it contains many so-called

components of white noise. Therefore, the quantization distortion in re-quantization can be suppressed by using a nonlinear quantizer to the coding network 54 and the decryption circuit 60 in drawing 1 .

[0089] Further for example, when a reversible sign decryption method is used to the coding network 54 in drawing 1 , and the decryption circuit 60, the high-efficiency-coding equipment input signal of this invention and a high efficiency decryption equipment output signal turn into the same signal, and the whole system serves as a reversible sign decryption method.

[0090] Moreover, when it has the same configuration as the coding method explained, for example in this example, it may act on validity more by changing the various setting-out parameters in a coding network. For example, when using the high efficiency decryption equipment of a configuration when a bit rate higher than a coding network 54 is set up to the coding network 51 in drawing 1 by changing the parameter of the usable total number-of-bits generating circuit 802 in drawing 4 , so that it may decrypt only using the coded signal inputted from the high efficiency decryption equipment input terminal 57 in drawing 1 , it acts effectively.

[0091] Moreover, since the input signal over the coding network 54 in drawing 1 is a differential signal of the signal supplied from the high-efficiency-coding equipment input terminal 50, and the signal by which sign decryption processing was carried out in the coding network 51 and the decryption circuit 52, it contains many so-called components of white noise. Therefore, in a coding network 54, it becomes possible, for example by changing a parameter so that more bits by the bit allocation 805 of an acoustic-sense permissible noise spectrum may be distributed in the rate decision circuit 809 of bit division in drawing 4 to perform bit allocation which was adapted for the input signal to a coding network 54.

[0092] this invention example can consider the above various deformation.

[0093]

[Effect of the Invention] In high efficiency coding and the decryption system of this invention, the following effectiveness can be acquired so that clearly also from the above explanation.

[0094] That is, even when the coding equipment and decryption equipment using a low bit rate are already used for the 1st, in case it is going to introduce coding of the quality of loud sound using a higher bit rate, and a decryption system, the system which has compatibility with existing coding equipment and decryption equipment can be offered.

[0095] high [2nd] -- since tone quality coding equipment and decryption equipment can be constituted using the existing cheap coding network for low bit rates, and a decryption circuit, creation of new coding and Decryption LSI is not needed, but it becomes possible to attain the object cheaply.

[0096] It becomes possible to suppress generating of the quantizing noise greatly generated with the property of input signals, such as Puri Echo, generated in the conventional coding and decryption processing by taking the difference of a decryption processing signal and an input signal also within coding equipment to the 3rd, and taking the configuration of sending the encoded information to decryption equipment.

[Translation done.]